brother and I made personal and explicit inquiry of him as to the fate of these bones, concerning which we were naturally anxious to know whether we had been correctly informed. His "reply" was so vague as to compel us to be content with the guarded expression we used. It will be seen that the "reply" he has now given is not more satisfactory. It shows, indeed, that two of the three bones or fragments which we had been informed were sent by M. Bouton had reached Prof. Owen, had been rightly recognized by the former and "returned" by the latter; but it says nothing as to their "fate," which remains as "unknown to us" now as it was then. One thing is certain—that on search being made last August in the Museum at Port Louis, they were not forthcoming.

Fully appreciating the terms of general approbation in which Professor Owen has been pleased to mention our paper, the carelessness as to the fate of these particular specimens, whatever may have been their number or condition, which he imputes to my brother and myself is so great that I need not apologize for troubling you with the assurance that it has no foundation in fact.

I remain, Gentlemen,

Athenæum Club, Pall Mall,
January 10, 1872.

Your obedient Servant,
Alfred Newton.

Tapirus villosus.

The British Museum has received from Mr. Buckley a series of specimens of different ages of *Tapirus villosus* from the Cordillera of Ecuador. The adult male is black, closely covered with rather short hair; the young is covered with abundance of longer hair; the young is marked with broad grey streaks more or less confluent or united into short grey lines. The nasal bone of the adult is elongate.—J. E. Gray.

A Letter concerning Deep-Sea Dredgings, addressed to Prof. Benjamin Peirce, *Superintendent, United States Coast Survey.* By Louis Agassiz.

Cambridge, Mass., December 2, 1871.

My dear Friend,—On the point of starting for the Deep-Sea Dredging-expedition, for which you have so fully provided, and which I trust may prove to be one of the best rewards for your devotion to the interests of the Coast Survey, I am desirous to leave in your hands a document which may be very compromising for me, but which I nevertheless am determined to write in the hope of showing within what limits natural history has advanced toward that point of maturity when science may anticipate the discovery of facts.

If there is, as I believe to be the case, a plan according to which the affinities among animals and the order of their succession in time were determined from the beginning, and if that plan is reflected in the mode of growth and in the geographical distribution of all living beings, or, in other words, if this world of ours is the work

of intelligence and not merely the product of force and matter, the human mind, as a part of the whole, should so chime with it, that, from what is known, it may reach the unknown; and if this be so, the amount of information thus far gathered should, within the limits of errors which the imperfection of our knowledge renders unavoidable, be sufficient to foretell what we are likely to find in the deepest abysses of the sea, from which thus far nothing has been secured.

I will not undertake to lay down the line of argument upon which I base my statement, beyond what is suggested in the few words preceding—namely, that there is a correlation between the gradation of animals in the complication of their structure, their order of succession in geological times, their mode of development from the egg, and their geographical distribution upon the surface of the globe. If that be so, and if the animal world designed from the beginning has been the motive for the physical changes which our globe has undergone, and if, as I also believe to be the case, these changes have not been the cause of the diversity now observed among organized beings, then we may expect from the greater depth of the ocean representatives resembling those types of animals which were prominent in earlier geological periods, or bear a closer resemblance to younger stages of the higher members of the same types, or to the lower forms which take their place now-a-days. And to leave no doubt that I have a distinct perception of what I may anticipate, I make the following specific statement.

It lies in the very nature of these animals that, among Vertebrates, neither Mammalia nor Birds can exist in deep waters; and if any Reptiles exist there, it could only be such as are related to the extinct types of the Jurassic periods, the Ichthyosauri, Plesiosauri, and Pterodactyles; but even of these there is very little probability that any of their representatives are still alive. Among the Fishes, however, I expect to discover some marine representatives of the order of Ganoids of both the principal types known from the secondary zoological period, such as Lepidoids, Sauroids, Pycnodonts, Cœlacanths, Amioids; and *Glyptolepis*-like species may even be looked for. Among Selachians some new representatives of Cestraciontes or Hybodontes may be forthcoming, connecting the latter more closely to *Odontaspis*. I also look forward to finding species allied to *Corax*, or connecting this genus with *Notidanus*, perhaps also Jurassic-like forms. Among Chimæroids we may expect some new genera more closely related to the extinct types of that family than those now living. Among ordinary fishes I take it for granted that *Beryx*-genera may be added to our list, approaching perhaps *Acanus*, or rather *Sphenocephalus*; also types allied to *Istieus*, to *Anenchelum*, and to *Osmeroides*, *Elops*, and *Argentina*. *Dercetis* and *Blochius* may also come up. Species of all classes of the animal kingdom which have been very rarely met with by fishermen and naturalists are likely to be found in the deepest waters, in which neither hooks nor nets are generally lowered. Nothing is known concerning the greatest depth at which fishes may live. Upon this point I hope to obtain positive data.

The Mollusks will, no doubt, afford a rich harvest of novelties, among which some may be of the deepest zoological interest. It stands to reason that a variety of Nautiloid Cephalopods may be discovered when *Nautilus* proper and *Spirula* are so rarely found alive; and among new forms there may be those combining characters of *Argonauta* with features of *Nautilus*; some may even be coiled up like *Turrilites*. Belemnitic Squids would appear natural. Among Gasteropods we may look for high-spired *Natica*-like types, for representatives of *Actæonella*, *Avellana*, and the like—for small Volutoids of the tertiary and cretaceous types, for Rostellarias, even for Nerinæas, and more particularly for forms intermediate between *Firula* and *Cypræa*. Among Acephala I should expect a variety of Myacea approaching those described in my monographs of that family from the jurassic and cretaceous formations, such as *Ceromya*, *Corimya*, *Circomya*, *Goniomya*, *Myopsis*, &c., with *Panopœa* and *Pholadomya*, and others recalling perhaps also *Cardinia*, *Gresslya*, or Cardiacea more closely related to *Conocardium* than the living species, perhaps leading to *Opis*, or *Trigoniæ* of extinct types akin to *Myophoria*, with *Pachymya*, *Diceras*, *Grammisia*, *Inoceramus*, *Pterinea*, *Monotis*, and *Posidonia*. Rudistes should take the place of oysters; and the harvest of Brachiopods should be large.

Among Crustacea it is natural to suppose that genera may be discovered reminding us of *Eryon* or of *Pemphyx*, *Gampsonyx*, or some Amphipods, and Isopods aping still more closely the Trilobites than *Serolis*, or Limuloids approaching that extinct family. The classification, embryology, and order of succession of Echinoderms is now so well known that it is perhaps still more easy to anticipate the character of discoveries in this branch of the animal kingdom than in any other. I expect, confidently, to find Spatangoids approaching *Holaster*, *Toxaster*, *Ananchytes*, *Hemipneustes*, or *Metaporhinus*, and others akin to *Dysaster*, Echinolamps approaching *Pygurus*, Nucleolites tending to *Clypeus*, Galerites like *Pyrina* or *Globator*, &c. &c., and, again, Cidarids akin to *C. glandifera* and *clavigera*, with *Glypticus*-like species, and *Codiopsis*, *Cœlopleurus*, *Cyphosoma*, and *Salenia*.

Among Starfishes the types of *Goniaster* and *Luidia* are likely to prevail, with simple-rayed Euryaloid genera, and among Crinoids a variety of genera reminding us of *Pentremites*, *Marsupites*, *Pentacrinus*, *Apiocrinus*, and *Eugeniacrinus*.

The question of the affinities of Millepora will probably receive additional evidence; and genera connecting more closely the Rugosa and Tabulata with one another and with the Acalephs may be expected in the shape of branching Heliopores and the like.

With the monograph of Pourtales upon the deep-sea corals before me, it would be sheer pretence to say any thing concerning the prospect of discovering new representatives of this or that type. His tables point them out already.

But there is a subject of great interest likely to be elucidated by our investigation—the contrast of the deep-sea faunæ of the northern with those of the southern hemisphere. Judging from what

Australia has already brought us, we may expect to find that the animal world of the southern hemisphere has a more antique character—in the same way as North America may be contrasted with Europe, on the ground of the occurrence in the United States of animals and plants now living here, the types of which are only found fossil in Europe.

A few more words upon another subject. During the first three decades of this century, the scientific world believed that the erratic boulders which form so prominent a feature of the surface geology of Europe had been transported by currents arising from the rupture of the barriers of great lakes among the Alps, or started from the north by earthquake-waves.

Shepherds first started the idea that within the valleys of Switerland these huge boulders had been carried forward by glaciers; and Swiss geologists (Venetz and Charpentier foremost among them) very soon proved that this had been the case. This view, however, remained confined to the vicinity of the Alps in its application, until I suggested that the phenomenon might have a cosmic importance, which was proved when I discovered, in 1840, unmistakable traces of glaciers in Scotland, England, and Ireland, in regions which could have had no connexion whatever with the elevation of the Alps. Since that time the *glacial period* has been considered by geologists a fixed fact, whatever may have been the discrepancies among them as to the extent of these continental masses of ice, their origin, and their mode of action.

There is, however, one kind of evidence wanting to remove every possible doubt that the greater extension of glaciers in former ages was connected with cosmic changes in the physical condition of our globe. All the phenomena related to the glacial period must be found in the southern hemisphere with the same characteristic features as in the north, with this essential difference, that every thing must be reversed: that is, the trend of the glacial abrasion must be from the south northward; the lee side of abraded rocks must be on the north side of hills and mountain-ranges, and the boulders must have been derived from rocky exposures lying to the south of their present position. Whether this is so or not has not yet been ascertained by direct observation. I expect to find it so throughout the temperate and cold zones of the southern hemisphere, with the sole exception of the present glaciers of Tierra del Fuego and Patagonia, which may have transported boulders in every direction. Even in Europe, geologists have not yet sufficiently discriminated between local glaciers and the phenomena connected with their different degrees of successive retreat on the one hand, and the facts indicating the action of an expansive and continuous sheet of ice moving over the whole continent from north to south. Unquestionably the abrasion of the summits of the mountains of Great Britain, especially noticeable upon Schiehallion, is owing to the action of the great European ice-sheet during the maximum extension of the glacial phenomena in Europe, and has nothing to do with the local glaciers of the British Isles.

Among the facts already known from the southern hemisphere are

the so-called rivers of stone of the Falkland Islands, which attracted the attention of Darwin during his cruise with Captain Fitzroy, and which have remained an enigma to this day. I believe it will not be difficult to explain their origin in the light of the glacial theory; and I fancy now they may turn out to be nothing but ground moraines, similar to the "Horsebacks" of Maine.

You may ask what the question of drift has to do with deep-sea dredging? The connexion is closer than may at first appear. If drift is not of glacial origin, but the product of marine currents, its formation at once becomes a matter for the Coast Survey to investigate; and I believe it will be found in the end that, so far from being accumulated by the sea, the drift of the lowlands of Patagonia has been worn away to its present extent by the continued encroachment of the ocean in the same manner as the northern shores of South America and of Brazil have been. . . . . .

Hoping some, at least, of my anticipations may prove true,

I remain, ever truly yours,

Louis Agassiz.

—*Bulletin of the Museum of Comparative Zoology at Harvard College, Cambridge, Mass.*, vol. iii. (Communicated by the Author.)

On the Fecundation of the Crayfish. By M. S. Chantran.

Hitherto we have been in uncertainty as to the question whether in the crayfish the fecundation of the ova takes place in the interior of the body of the female or on the outside of it. I think I have determined that it is on the outside that this phenomenon takes place; and the following are the conditions.

In my note read to the Academy on the 4th of July 1870 *, I stated that the male deposited his fecundating material, in the form of spermatophora, upon the plates of the caudal fan and on the plastron of the female, and that the period of the oviposition varied from the second to the forty-fifth day after the copulation.

When the moment of oviposition arrives, the female raises herself upon her feet, and then her abdominal appendages secrete for several hours a very viscous greyish mucus; then she lies upon her back, and bends her tail towards the opening of the oviducts, so as to form a sort of chamber, already noticed by Lereboullet, in which, during the following night, the ova are collected as they are expelled from the genital organs. In different females this expulsion lasts from one to two hours. The ova, which are always turned so as to present their whitish spot or cicatricula above, as if to receive more easily the influence of fecundation, are thus immersed in the greyish mucus, which in a manner binds the false legs and the margins and extremity of the tail to the thorax, and which assists in bounding the pouch or chamber above mentioned, in which a certain quantity of water is enclosed with the ova and the mucus. Immediately after oviposition we may detect in this mucus and water the presence of spermatozoids † precisely similar to those which are contained in

* See Ann. & Mag. Nat. Hist. ser. 4. vol. vi. p. 265.

† Here they are mixed with pale yellowish drops and a certain num-